



SECTION 1 INTRODUCTION

• Click here to see video.



Virtually all types of asphalt used in the United States are products of the refining of crude petroleum. Asphalt is produced in a variety of types and grades ranging from hard and brittle solids to thin liquids. The asphalt used for paving is normally in the middle of these two extremes. Although paving asphalt is a semi-solid or solid at ambient temperatures, it can be readily liquefied by heating, by adding a petroleum solvent, or by emulsifying it in water.

In the production of hot mix asphalt (HMA), heat is used to liquefy the asphalt so it will coat the aggregate and remain workable during transport, laydown and compaction. As the asphalt cools, it hardens and regains the binding properties that make it an effective paving material. When a petroleum solvent such as naphtha or kerosene is added to the base asphalt to make it fluid, the product is called a cutback asphalt. In the field, the solvent evaporates as the cutback cures, restoring the asphalt's binding properties.

When asphalt is milled into microscopic particles and dispersed in water with a chemical emulsifier, it becomes an asphalt emulsion. The tiny droplets of asphalt remain uniformly suspended until the emulsion is used for its intended purpose. In the emulsion state, the emulsifier molecules orient themselves in and around droplets of asphalt. The chemistry of the emulsifier/asphalt/water system determines the dispersion and the stability of the suspension. When emulsions are used in the field, the water evaporates into the atmosphere, and the chemical emulsifier is retained with the asphalt.

1.1 History of Asphalt Emulsion

Emulsions were first developed in the early 1900s. It was in the 1920s when emulsions came into general use in pavement applications. Their early use was in spray applications and as dust palliatives. The growth in the use of asphalt emulsions was relatively slow, limited by the type of emulsions available and a lack of knowledge as to how they should be used. Continuing development of new types and grades, coupled with improved construction equipment and practices, now gives a broad range of choices. Virtually any roadway requirement can be met with emulsions. Judicious selection and use can yield significant economic and environmental benefits.



Table 1-1 The Major Uses of Asphalt Emulsion

Surface Treatments	Asphalt Recycling	Other Applications
Fog sealing	Cold in-place	Stabilization (soil and base)
Sand sealing	Full depth	Maintenance patching
Slurry sealing	Hot in-place	Tack coats
Micro-surfacing	Central plant	Dust palliatives
Cape sealing	Cold in-place	Stabilization (soil and base)
		Prime coats
		Crack filling
		Protective coatings

A slow but steady increase in the amount of emulsions used came about between 1930 and the mid-1950s. Following World War II, traffic loads and volumes increased so much that roadway designers began to curtail the use of asphalt emulsions. Instead, they specified hot mix asphalt requiring the use of asphalt cement. While the volume of asphalt cement used has increased greatly since 1953, the combined use of other asphalt products has remained almost constant. But there has been a steady rise in the volume of asphalt emulsions used.

Subsequently, several factors have contributed to interest in the use of asphalt emulsions:

- The energy crisis of the early 1970s. The Middle East oil embargo prompted conservation measures by the U.S. Federal Energy Administration. Asphalt emulsion does not require a petroleum solvent to make it liquid. Asphalt emulsions can also be used in most cases without additional heat. Both of these factors contribute to energy savings.
- Concerns about reducing atmospheric pollution. There are little or no hydrocarbon emissions from asphalt emulsions.
- The ability of certain types of asphalt emulsions to coat damp aggregate surfaces. This reduces the fuel requirements for heating and drying aggregates.
- Availability of a variety of emulsion types. New formulations and improved laboratory procedures have been developed to satisfy design and construction requirements.
- The ability to use the cold materials at remote sites.
- The applicability of emulsions for use in the preventive maintenance to increase the service life of slightly distressed existing pavements.

Two major factors, energy conservation and atmospheric pollution, prompted the use of asphalt emulsion in applications that were typically supported by cutback asphalt. In one of the early actions, the **Federal Highway Administration** (FHWA) issued notices that directed attention to fuel savings that could be realized by using asphalt emulsions instead of cutback asphalts. While the substitution was not mandatory, it was strongly suggested that it be considered. Since that time, all states are substituting, allowing the substitution of, or even mandating the use of asphalt emulsions in place of cutback asphalts.

1.2 Future of Asphalt Emulsion



The demand for a well maintained, efficient highway network continues. Asphalt is essential to meet these requirements. The **Federal Highway Administration** annual survey reported in "Highway Statistics" shows that the United States has about 6.3 million kilometers (3-9 million miles) in the roadway network. The survey also shows that about 93 percent of the paved roads have asphalt surfaces. The 1993 survey showed 19.2% of the paved mileage on Interstate highways is in "fair" condition, 24.1 % is in "mediocre" condition, and 8.4% in "Poor" condition. Of the other major highways, 28.2% of the mileage is in "fair" condition, 22.9% in "mediocre", and 11.0% in "poor" condition. This means that 37,600 kilometers (23,400 miles) of Interstates and almost 380,000 kilometers (236,000 miles) of other major highways are either in need of repair, or soon will be. Not included in these figures are the 89.1 % of other roads classified as collectors and locals.

The FHWA reports that the preservation of the nation's highways is currently a priority at all levels of government. The renewed interest has resulted in increased fiscal resources allocated to improving pavements. In the past, the major effort of FHWA has been new highway construction. There is now increasing emphasis on maintenance. Asphalt emulsions are an effective method of preventative and corrective maintenance of existing pavements.

In 1993, local, state and federal government spent \$39.7 billion on capital improvements for our highways, and \$23.4 billion was spent on maintenance and traffic services. Maintenance accounted for 31.2% of government highway spending in 1993, compared with 28.6% in 1973.

An example of the renewed interest is the proposed National Highway System (NHS) submitted to Congress in December of 1993. The goals of the NHS include a more effective linking of industry, recreation, medical services, tourism and disaster services with a national transportation system. It is expected to greatly improve urban traffic flow, improving air quality by reducing emissions up to 30%. The proposed incident management will also increase safety and decrease medical costs.

Current projections indicate the NHS will pay for itself within 15 years just in the decrease in costs related to fatalities. The improvements in additional economic development and job creation facilitated by improved transportation are expected to have a major impact on our economy. The NHS is projected to carry over 42% of the nation's travel. The NHS will encompass over 73,200 km (45,500 mi) of existing Interstate, 176,547 km (109,701 mi) of other existing highways, and 6,256 km (3,887 mi) of new construction. Approximately 60% of the existing mileage (152,640 km - 94,850 mi) to be included in the NHS is currently listed as being in fair, mediocre or poor condition, and will need rehabilitation. The Strategic Highway Research Program (SHRP) was a 5 year, \$150 million research program to improve performance and durability of our nation's roads and to make those roads safer for both motorists and highway workers. One of the products of SHRP is the Superpave asphalt mix design system for hot mix asphalt. The Superpave system uses performance based criteria, taking into consideration specific project conditions such as climate, existing structure, traffic patterns and loads. Superpave includes new methods of characterizing asphalt binders used

in hot mix asphalt. While the Superpave binder specifications did not specifically address asphalt emulsions at the time of this writing, the shift in the ways highway engineers are now looking at asphalt testing will undoubtedly have an effect on asphalt emulsions in the future.



The demands for a well-maintained roadway will continue to be high, and the demand for asphalt will persevere. There will be increased limitations in supply of quality raw materials. Because of these tremendous needs, every attempt should be made to utilize road materials in an efficient, conservative manner. This means increased use of recycling and high performance materials such as modified emulsions.

The asphalt paving industry is seeing many changes. In recent years asphalt emulsion technology has been innovative in meeting the challenges of increased traffic, shrinking budgets and environmental concerns. A clear understanding of the “why and how” of using asphalt emulsions offers a promise of efficient use. The proper use of asphalt emulsions can result in high performance pavements and thrifty but versatile maintenance systems. This manual is directed toward those ends.

To aid in understanding unfamiliar technical terms, a glossary is provided in **APPENDIX A GLOSSARY**.